Ultrafast Charging

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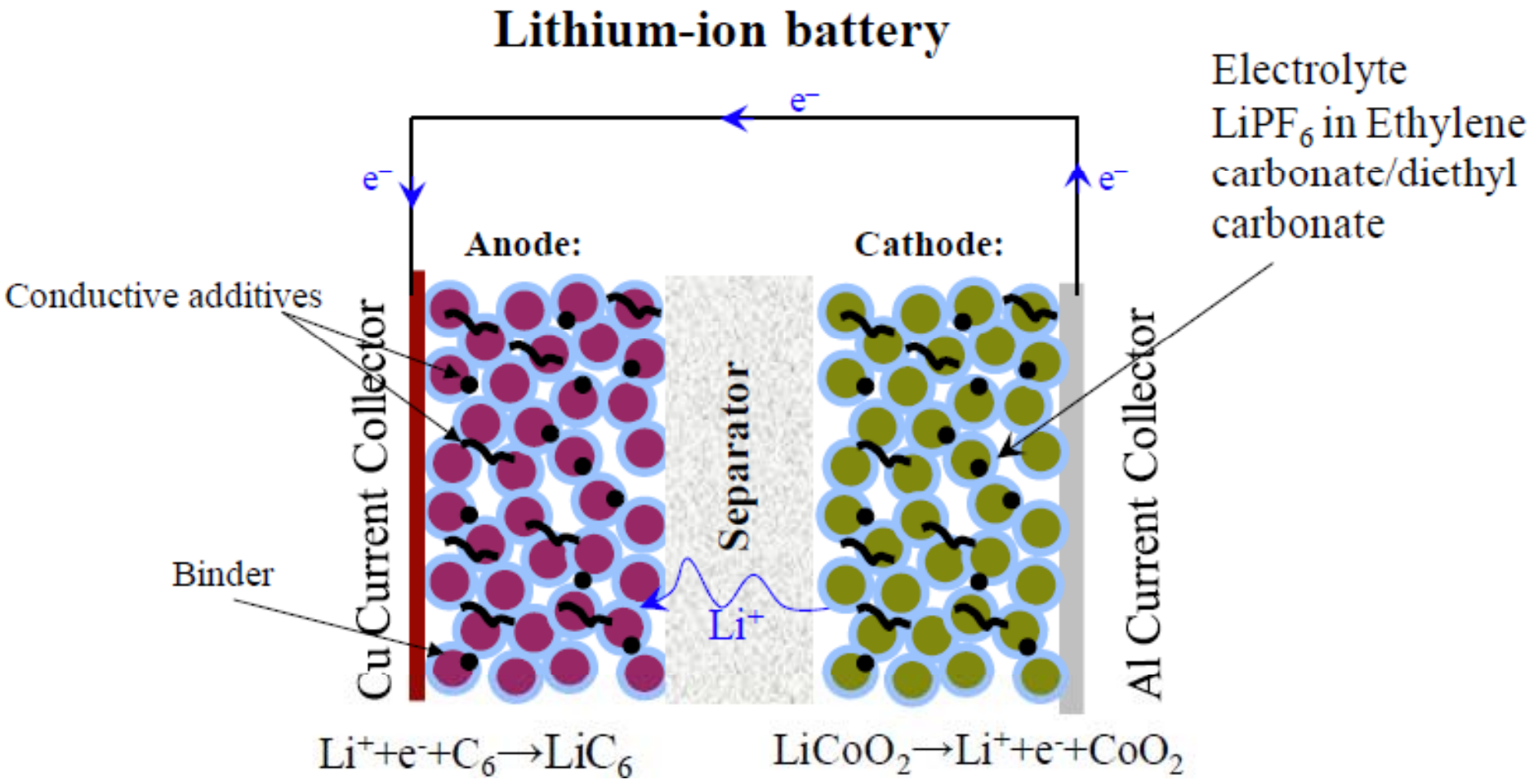
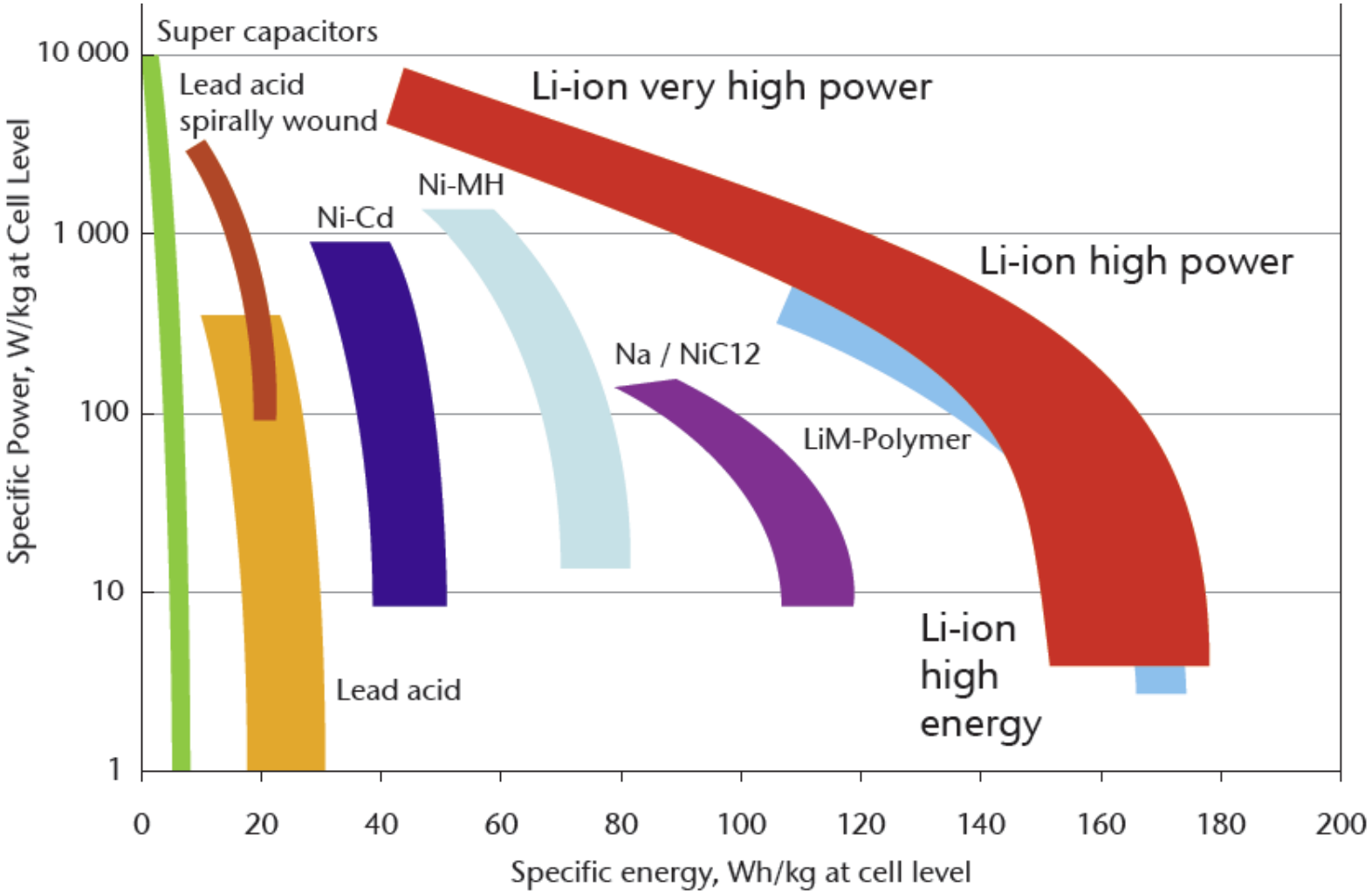
“new form factors of matter lead to new functions”

Inside a Li-ion Battery



Venkat Srinivasan, LLNL
http://berc.lbl.gov/venkat/files/batteries-for-vehicles.pdf

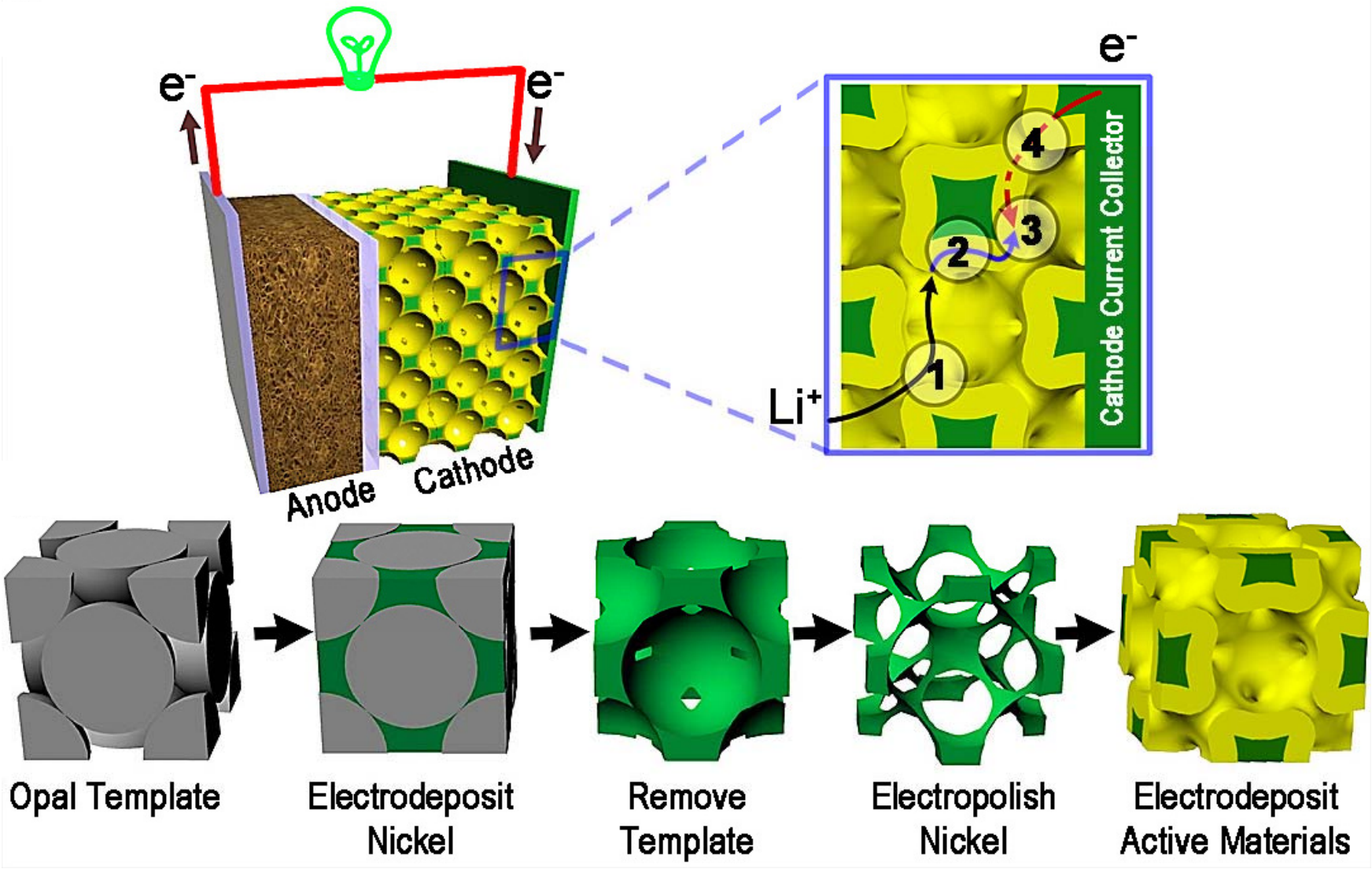
Ragone Plot



Peak Charging Rate and Peak Specific Power Related
But, be careful (heat, Li plating, SEI stability…)

Bicontinuous Battery Electrode (Cathode)

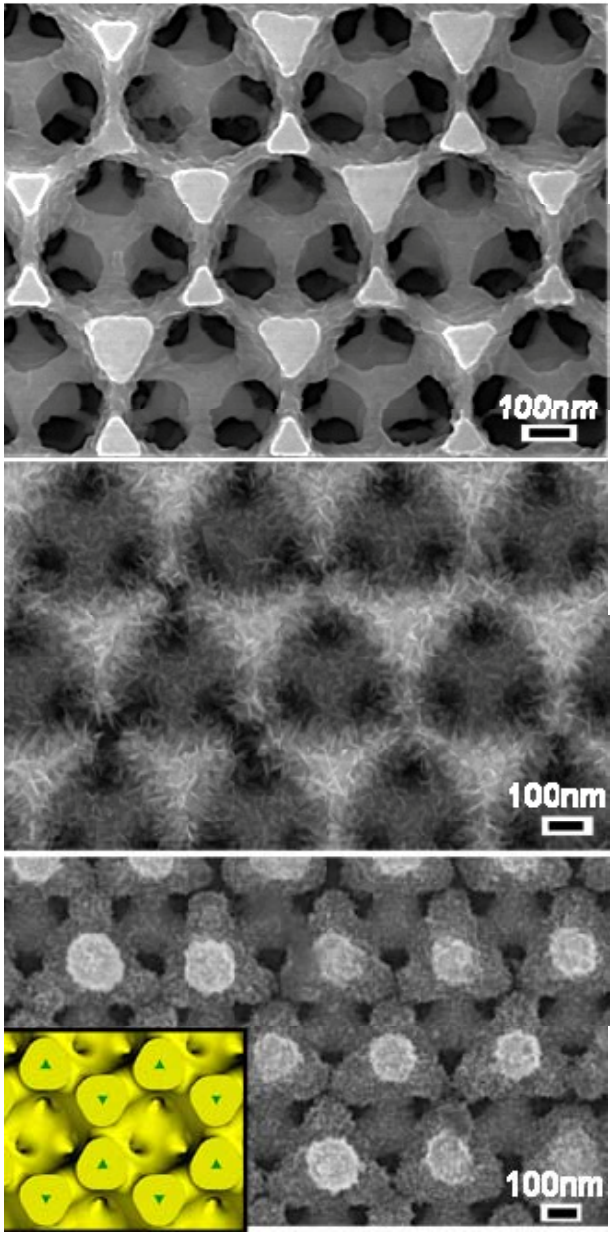
Wrap a surface into a 3D structure maximizing kinetics and capacity



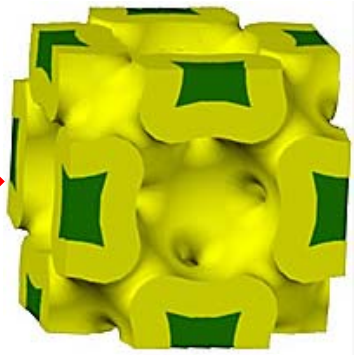
PV Braun et al., Nature Nanotechnology, 2011

Bicontinuous Battery Electrode (Cathode)

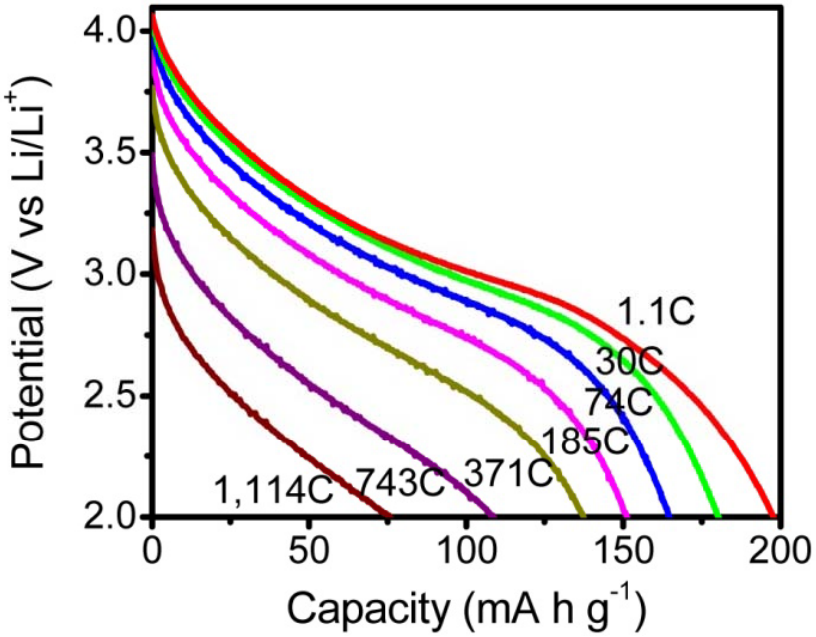
Li-ion ($LiMnO_2$)



Metal Framework



Coated Framework



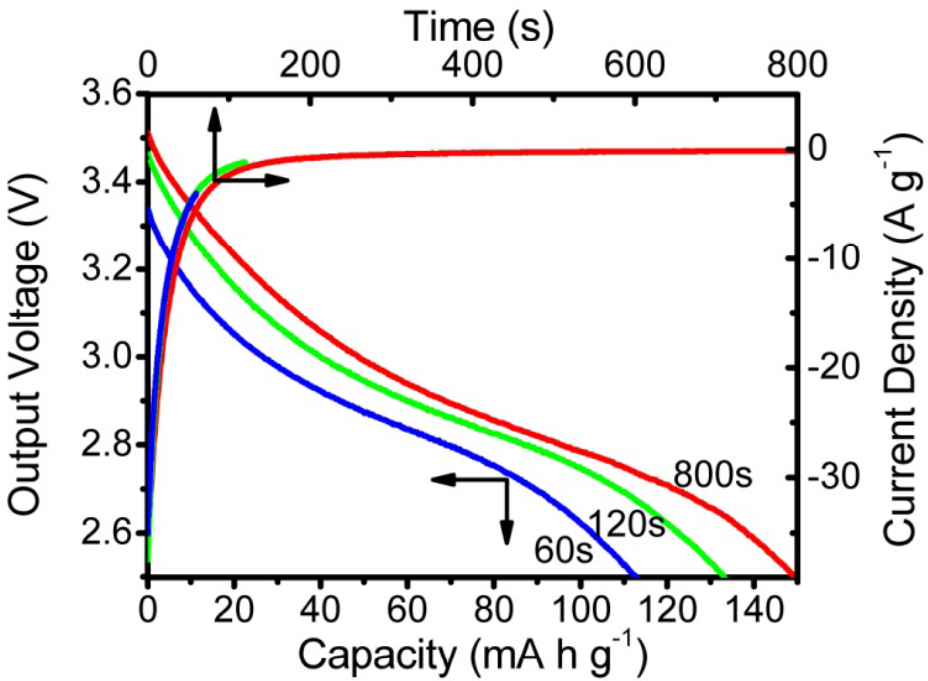
Significant capacity retention at 371C

1C is defined as the current required to fully discharge the battery in 1 hour, so 371C is a complete discharge in ~10 sec

Potential for ultrafast charging along with ultrafast discharge

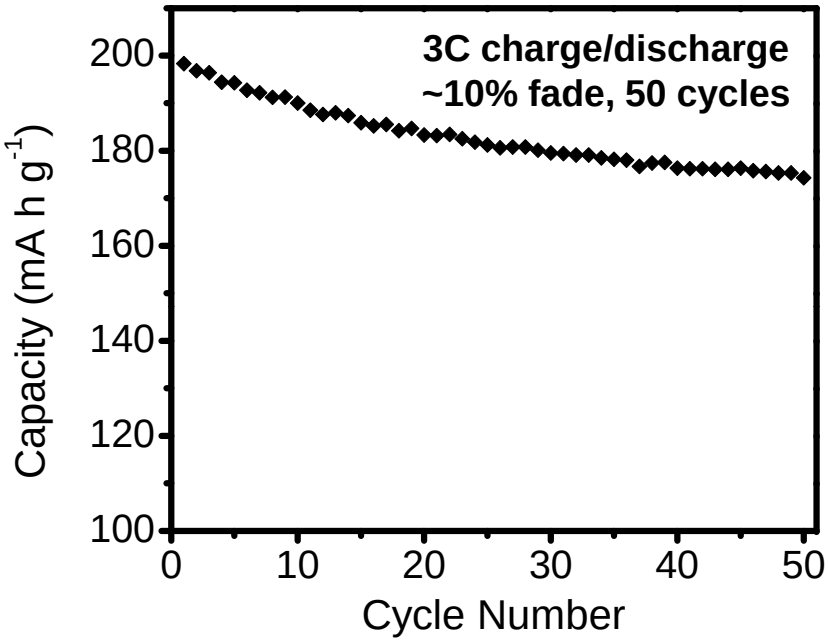
Ultrafast Charging

Bicontinuous Lithiated MnO_2/Graphite Cell



Potentiostatic charging (3.5V)
3C discharge
Nearly complete charge after 120 sec.

Lithiated MnO_2 cathode



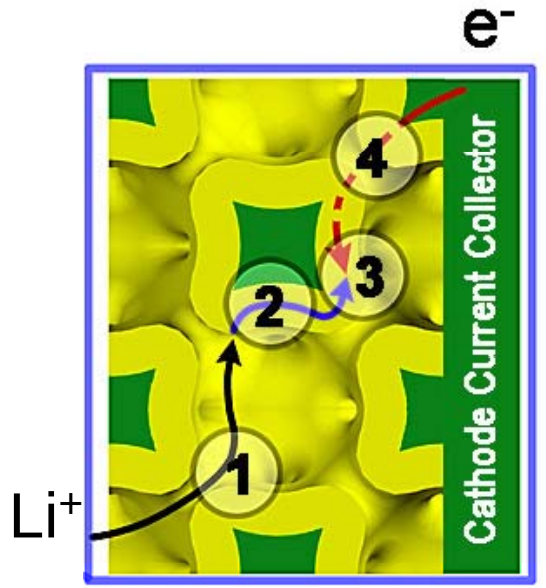
Notes (disclaimers):

1. **Not a matched cell (anode oversized)**
2. **~100X electrolyte**
3. **Capacity is based on active material of the cathode only**

PV Braun et al., Nature Nanotechnology, 2011

Enabling Mechanism for Ultrafast Charge/Discharge

1) Facile ion transport through interconnected pore network
2) Short solid-state ion diffusion length
3) Rapid electrochemical processes (large area electrode)
4) Low resistance electrical network



Electrolytically active material is sandwiched between efficient ion and electron transport networks

Low metal filling fraction (<10%) and high volume fraction of electrolytically active material (>50%) yields high energy density